of time. Again, a slight curvature may accelerate the growth on the upper side of a dicotyledonous stem, whereas a more pronounced bend may produce eccentricity upon the under side or inhibit the growth of both the upper and under sides and lead to lateral eccentricity.

In the fifth and concluding section of the volume, JACCARD elaborates the following hypothesis: "The morphological characters common to all trees are determined (1) by the polarity of their organs, that is to say, by their tendency to grow most rapidly in a vertical direction, and (2) by the modifications which the exigencies of nutrition and the action of external forces (gravity, heat, light) impress upon this polarity. These modifications manifest themselves through the osmotic force of cells which engenders, on the one hand, two circulatory currents (the ascending sap and descending current of elaborated substances), and, on the other hand, mechanical strains and stresses (pressure of turgescence) capable of influencing the form of cells. . . . . In general, such variations in gross form and anatomical structure, as may be observed at different levels in the concentric, vertical axes of trees, are determined by the physical conditions of the transpiration stream and the flow of elaborated sap. On the contrary, the anatomical differentiation and variations in transverse sections, which are concomitants of the eccentric growth of inclined or horizontal branches, are due to mechanical forces engendered by the unequally rapid growth of the antagonistic sides of these organs, under the asymmetrical influence of gravity and light."

Although the author is justified in contending that the problem of the growth and form of stems and branches should be attacked from the point of view of fundamental physiological phenomena, and in rejecting teleological conclusions as unscientific, he extends his own generalizations much farther than is warranted by his experimental data. When one considers how little is actually known about the "ascent of sap," the growth and activities of the cambium and its derivative tissues, the distribution of food substances and osmotic pressures, and, in general, concerning transpiration, metabolism, and translocation and their interactivities in arborescent plants, one is inclined to question whether there are available at present sufficient reliable data to form the basis for such a comprehensive hypothesis as is formulated by the author.—I. W. BAILEY.

Factors of fruitfulness.—A contribution by WIGGINS[6] covers investigations for 5 years, chiefly upon trees that were 8 years old at the beginning of the experiment in 1913. Attention was centered upon the individual fruiting branch "in an effort to determine the effect of certain conditions and practices upon the development and performance of the individual fruit spur."

The data for the performance of the individual spurs were obtained from 8-year-old Rome, Gano, Winesap, Grimes, York, and Jonathan. The first selection was made of fruiting spurs, but after that a blossoming spur was

[6] WIGGINS, C. C., Mo. Exp. Sta. Research Bull. no. 32. 1–60. 1918.

considered to be a fruiting spur for the season in which it bloomed. It might be questioned whether the author was justified in making such an assumption.

Jonathan, Winesap, and Grimes were found to produce a fair amount of bloom each year, but with no exceedingly productive seasons; while Rome, York, and Gano were found to have a very high percentage of bloom one season and a comparatively low one the next. Winesap and Jonathan, in the order named, were able to develop blossoms in successive seasons on the same spur in a much greater proportion than the other varieties. The difference between alternating and non-alternating varieties seems to be due to the ability of the spurs of the regular bearing kinds to blossom two years in succession. The most effective fruiting age for the spurs, irrespective of the type of bearing, appeared to be from 3 to 7 years.

Determinations of the relative amounts of food reserve in the fruit spurs were made by finding the lowering of the freezing point in the spur sap by means of a Beckman apparatus. Only relative proportions of reserves were indicated by the lowering of the freezing point, and starch not at all. It was found that sap from the bearing spurs had a slightly higher concentration during a considerable portion of the year than sap from non-bearing spurs. It must be remembered, however, that the method of analysis gave no indication of the amount of starch that might have been present. It was found that during the latter part of June and early July there was a sudden drop in concentration of sap, both in fruiting spurs and non-fruiting spurs, and at that time both kinds of spurs reached a similar degree of concentration. The author concluded also that little difference in concentration of the cell sap could be attributed to soil conditions or to the number of fruits being produced upon a spur.

Chemical analysis of the spurs of Yellow Transparent were made in order to ascertain the amounts of sugars and starch stored. It was found, in the majority of cases, that there was a slightly greater amount of sugar, both reducing and total, in the non-bearing spurs. The starch content of the non-bearing spurs did not average quite so high as that of the bearing spurs, but there was considerable variation in these results. Inasmuch as the determinations made were comparatively few in number (22) and covered only the period from late October to April, no conclusions were drawn. A determination of nitrogen would have made this work much more valuable.

It was found that non-bearing spurs had a larger total leaf area than bearing spurs, and that the difference was due more to the number of leaves than to the size of the individual leaves.

The effects of girdling upon the concentration of cell sap were determined by noting the depression of the freezing point. The sap of all parts above the girdle was found to have an increased concentration, and the sap of all parts below the girdle a decreased density when compared with sap from corresponding parts of similar but ungirdled trees. The greatest effect was observed upon the sap of the trunk, and the difference became less as the distance from the girdle increased; consequently the leaves and twigs at the periphery of the tree, where the majority of the fruit buds were formed, did not show such a great variation.

The experiment to determine the effect of fertilizers upon fruitfulness was started with 1-year-old Rome on Paradise stock. The trees were planted in separate large wooden tubs, half of them filled with Missouri River sand and half with loess soil. The fertilizers were applied just as growth was beginning in the spring. It was found that nitrogen was a very decisive factor in the growth of the tree, the development of fruiting wood, and the formation of blossoms. Phosphorus and potassium, either singly or in combination, had no apparent effects.

The effect of various systems of soil management was noted upon the concentration of the cell sap. There were 5 different cultural plots: clean cultivation with soy beans or cow peas planted in June; successive crops of corn; seeded to red clover in alternate years; successive cropping of alfalfa; and permanent timothy sod. "These experiments showed conclusively that tillage methods materially affected the sap density of the twigs of the apple tree." The plots ranked in sap concentration of the twigs as follows: alfalfa; timothy and blue grass sod; clover; corn; and clean cultivation with legume cover planted in June. There was very little difference between the clover and corn plots. The trees in the most intensively cultivated areas were considerably the largest.

A group of 64 one-year-old Delicious trees were used to study the effect of pruning methods upon the formation of fruiting parts. During the first 3 years the trees headed at 2 feet made a greater amount of twig growth and produced a larger number of short branches or potential fruiting wood than did the trees headed at 5 feet. Each month a separate 5- to 6-year-old Jonathan tree was subjected to etherization. Very little effect was observed upon the concentration of the sap of the spurs or of the leaves, and the small difference noted appeared to be only temporary. A rather extensive bibliography accompanies the article.—H. W. RICHEY.

Phylogeny of seed plants.—At the St. Louis meeting of the American Association, the botanical program included a symposium on the phylogeny of seed plants. The three invitation papers have just been published. The three investigators, working upon different phases of the problem, have shown tendencies in the evolution of the groups with which they are concerned; and while the phylogeny of seed plants still represents a great field for exploration, some results have been obtained, and the problem has been advanced a little toward the distant solution.

BUCHHOLZ[7] has made a comprehensive survey of the development of the embryo and polyembryony in the conifers, much of the subject-matter being

[7] BUCHHOLZ, J. T., Embryo development and polyembryony in relation to the phylogeny of conifers. Amer. Jour. Bot. 7:125–145. 1920.